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HABITAT OF THREATENED SPECIES OF *SERRURIA* AND *PROTEA* ENDEMIC TO WESTERN CAPE COASTAL FLATS

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Abstract

The habitats of four species of *Serruria* and two species of *Protea*, all threatened endemics in Coastal Fynbos and Coastal Rhenosterbosveld, are described. These habitats are compared with those of other threatened species of Proteaceae and Restionaceae.

Uittreksel

HABITAT VAN BEDREIGDE *SERRURIA* EN *PROTEA* SPESIES ENDEMIES AAN DIE WESTELIKE KAAPSE KUSVLAKTES

Die habitatte van vier *Serruria* spesies en twee *Protea* spesies word beskryf en vergelyk met die habitatte van ander Proteaceae en Restionaceae spesies. Hierdie bedreigde spesies kom met beperkte verspreidings in kusfynbos en kusrenosterbosveld voor.

Introduction

Several recent papers have described the habitats of rare and threatened species of Proteaceae and Restionaceae on the western Cape coastal flats (Milewski & Esterhuysen, 1977; Milewski, 1977, Milewski, 1978). This paper describes the habitats of six additional threatened species of Proteaceae, in relation to those of the species previously dealt with in this way. Knowledge of the habitats of threatened species is an urgent prerequisite for their conservation.

Methods

Six species were chosen for study, each restricted to a small geographical range of less than 700 km^2 on the western coastal flats of the south-western Cape (Milewski & Esterhuysen, 1977; Milewski, 1978). The study species were *Serruria trilopha* Knight, *S. linearis* Salisb. ex Knight, *S. furcellata* R. Br., *S. cyanoides* R. Br., *Protea odorata* Thunb. and *P. mucronifolia* Salisb. All are evergreen perennials. *Protea odorata* and *P. mucronifolia* grow as 0,5–0,8 m high, single-stemmed, firm woody shrubs (caespitose nanophanerophytes). The *Serruria* species grow as shrublets (chamaephytes) arising from a small lignotuber at ground level as a number of sparsely branched lax stems to a height of 0,2–0,7 m, lowest for the sprawling *S. trilopha*.

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Methods were similar to those used by Milewski (1978). The thoroughness of the investigation was severely limited by the study species' relict status. All known remaining populations were investigated, "populations" of a species being arbitrarily defined as stands farther than 2 km apart (Milewski & Esterhuysen, 1977; Milewski, 1978). Data were recorded from two populations of all species except *S. furcellata* and *S. cyanoides* (only one population of each evidently remains), and *S. linearis* (three populations). The substrate, and the physiognomy and general floristics of vegetation, associated with each population were subjectively recorded. All associate species in the Proteaceae and Restionaceae (Milewski, 1978), growing within 0,5 m of the study species, were listed. This was done for each of a minimum total of 50 study plants scattered throughout each population except for *S. furcellata*, of which only 25 plants could be found.

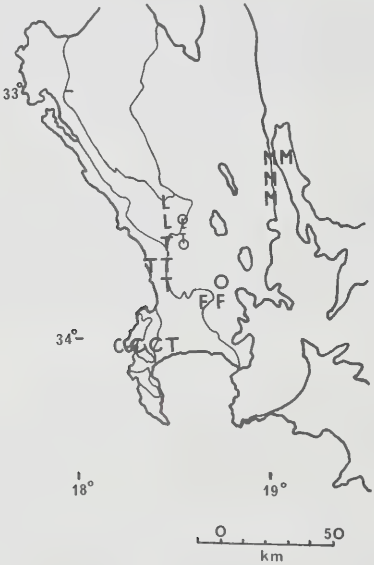

FIG. 1.
The western Cape coastal flats, showing distribution of *Protea odorata* (O), *P. mucronifolia* (M), *Serruria trilopha* (T), *S. linearis* (L), *S. furcellata* (F) and *S. cyanoides* (C) in relation to biotic areas. Localities were plotted using a twelfth-degree grid. Each symbol represents the occurrence of the species within a square corresponding to one-ninth of the area of a quarter-degree grid-square (smaller versions of the symbols were used where two species were recorded in the same grid-square). See Milewski and Esterhuysen (1977) and Milewski (1977) for explanation of biotic areas.

RESULTS AND DISCUSSION

Serruria trilopha, *S. linearis* and *S. furcellata* are associated with adjacent areas of pale, leached Quaternary sand (Table 1, Figs 1 & 2). This sand occurs as a mantle of variable depth on flat to gently sloping landscapes (Table 1). The associated vegetation is Coastal Fynbos (Table 1).

Herbarium labels indicate that *S. cyanoides* formerly occurred at altitudes between 30 m and 550 m ''on hill slopes and on flats''. Collection sites include ''dunes'' at the lowest altitudes and ''sandy south-east slopes'' of mountains at the highest altitudes. *Serruria cyanoides* is today known only from aeolian sand covering a gently sloping saddle on the mid-altitude slopes of a coastal mountain (Table 1). The associated Coastal Fynbos differs from that associated with *S.*

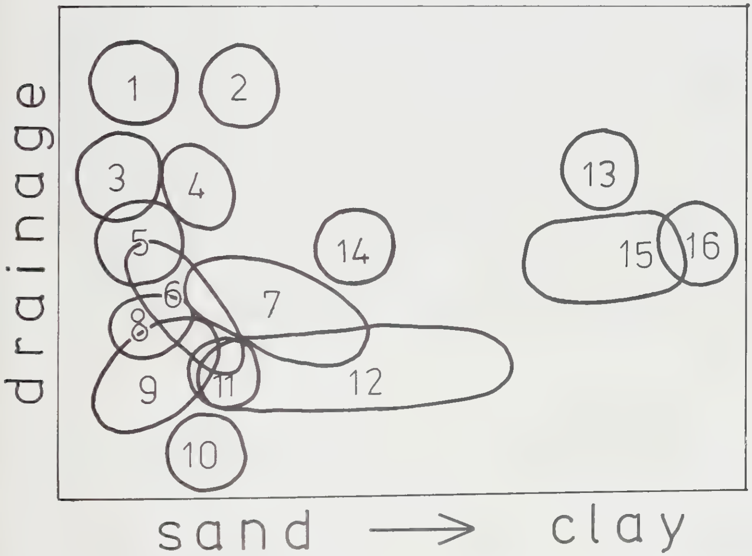

FIG. 2.

Diagrammatic representation of the habitats of 16 threatened species of Proteaceae and Restionaceae on the western coastal flats of the south-western Cape excluding the Breërivier Valley, drawn subjectively on the basis of data on associates in the Proteaceae and Restionaceae, and observation of substrates. 1 = *Serruria trilopha*, 2 = *S. cyanoides*, 3 = *S. linearis*, 4 = *S. furcellata*, 5 = *Chondropetalum acockii*, 6 = *S. ciliata*, 7 = *Elegia prominens*, 8 = *Restio micans*, 9 = *Leucadendron levisanus*, 10 = *L. floridum*, 11 = *Restio sabulosus*, 12 = *E. verreauxii*, 13 = *Protea mucronifolia*, 14 = *Diastella buekii*, 15 = *Protea odorata* and 16 = *L. verticillatum*. Overlapping areas indicate that the species coexist in part of their habitat as associates (Milewski & Esterhuysen 1977; Milewski 1977, 1978). *Thamnochortus fraternus*, a species of well-drained, neutral to alkaline sand, was omitted.

trilopha, S. linearis and *S. furcellata* (Tables 1 & 2). The presence of *Thamnochortus erectus* and *Leucadendron coniferum* (Table 2) suggests that the associated sand is younger and less leached than that on which the other *Serruria* species grow (Taylor, 1969; Boucher, 1972; Milewski, 1977). This substrate is usually found elsewhere as eroded sublittoral dunes (Taylor, 1969).

The communities of Restionaceae and Proteaceae associated with *S. trilopha* and *S. linearis* were 46,1 % similar to each other, whereas they were respectively only 20,3 % and 12,5 % similar to that associated with *S. cyanoides*. These figures were calculated on the basis of the Czekanowski coefficient following Milewski (1978). This supports the suggestion that the habitat of *S. cyanoides* is distinct from those of the other study species of *Serruria*.

Protea odorata and *P. mucronifolia* are also allopatric (Fig. 1). Both occur on clay-rich soil on flats and gentle slopes (Table 1, Fig. 2). The associated vegetation is a form of Coastal Rhenosterbosveld (Table 1, Fig. 1). The associated communities of Restionaceae and Proteaceae (Table 3) were 30,3 % similar between the two species, on the basis of the Czekanowski coefficient (following Milewski, 1978). This suggests that the habitat of *P. odorata* is distinct from that of *P. mucronifolia* (Milewski & Esterhuysen, 1977; Milewski, 1977) despite the apparent similarity of the associated climate and substrate.

The habitats of *S. trilopha, S. linearis* and *S. furcellata* may be compared with those of partly sympatric threatened species also occurring on sand (Milewski & Esterhuysen, 1977; Milewski, 1977, 1978). These species, including the congener *S. ciliata*, grow under conditions of poorer drainage than the present study species (Fig. 2). The habitats of *P. odorata* and *P. mucronifolia*, compared in the same way, are similar to that of *Leucadendron verticillatum* (Fig. 2).

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TABLE 1

Vegetation and environment associated with study species of *Serruria* and *Protea*

Study species	Description of vegetation		Substrate and locality
	General	Detailed	
S. trilopha	Scattered plants in a mainly restioid-ericoid (*sensu* Taylor, 1978) Coastal Fynbos, 0,4–1,5 m high, with 65–75 % projective foliage cover	(i) A main 0,5 m stratum of tufted restioids (*sensu* Taylor, 1978) (e.g. *Thamnochortus punctatus*) and ericoid shrubs (*Phylica cephalantha*, with e.g. *Cliffortia falcata*, *Lachnaea capitata*, *Cryptadenia grandiflora*, *Staavia radiata*, *Diosma oppositifolia*, *Stylapterus fruticulosus* and *Phylica stipularis*; a sparse ground stratum of forbs (e.g. *Helichrysum indicum*), wiry restioids (e.g. *Leptocarpus vimineus*), grasses (e.g. *Ehrharta ramosa*), sedges (e.g. *Ficinia deusta*), succulents (e.g. *Lampranthus amoenus*) and the creeping shrub *Leucospermum hypophyllocarpodendron*; scattered proteoid (*sensu* Taylor, 1978) and ericoid shrubs (e.g. *Protea pulchra*, *Erica mammosa*) emergent to 1,0 m	sandy slope, Koeberg Hill; virtually pure sand
		(ii) Similar to the above; conspicuous plants included *Staavia radiata*, *Cliffortia falcata*, *Putterlickia pyracantha*, *Willdenowia striata*, *Thamnochortus punctatus*, *Protea repens* and *Rhus laevigata*	sandy flats adjacent to low dunes bearing broad-leaved scrub (strandveld *sensu* Taylor, 1978), Blouberg Farm; small proportion of clay in the sand
		(iii) A population of *S. trilopha* or an allied taxon occurred on the Paardeberg on granite-derived sandy loam in a community dominated by the tufted restioid *Thamnochortus bachmannii* (Associates: *Willdenowia arescens*, *W. striata*, *Restio cuspidatus*, *R. duthieae*, *R. monanthus*, *Leptocarpus vimineus*, *Cannomois acuminata*, *Leucospermum calligerum*, *L. hypophyllocarpodendron*, *Leucadendron lanigerum*, *Serruria burmannii*, and *S. brownii*.	
S. linearis	Scattered plants in a mainly ericoid-restioid (*sensu* Taylor, 1978) Coastal Fynbos, similar to vegetation associated with *S. trilopha*, with 65–75 % projective foliage cover	(i) A main 0,6 m stratum of ericoid shrubs and tufted restioids (*Phylica cephalantha* and *Thamnochortus punctatus* co-dominant)	sandy flats, Kalabaskraal

		(ii) Two populations: similar to the above but with a well-developed proteoid stratum (shrubs of *Leucospermum parile* to 1,2 m) above the main 0,8 m stratum of ericoid shrubs and tufted restioids	gently undulating sandy base of Dassenberg; virtually pure sand
S. furcellata	Scattered plants in a mainly restioid-ericoid Coastal Fynbos, 1,0–1,5 m high, similar to the above and to vegetation described for *Chondropetalum acockii* at this locality by Milewski and Esterhuysen (1977)	A main 0,8 m stratum of ericoid shrubs (e.g. *Staavia radiata*) and tufted restioids (e.g. *Thamnochortus punctatus, Willdenowia sulcata*), a ground stratum of creeping shrubs (e.g. *Leucospermum hypophyllocarpodendron*) and forbs, and very scattered emergent proteoid (e.g. *Protea repens*) and tall ericoid (e.g. *Erica mammosa*) shrubs to 1,5 m	patch of sand on flats near Bellville
S. cyanoides	A mainly graminoid (*sensu* Taylor, 1978) fynbos, resembling Taylor's (1969) *Thamnochortus erectus* Dune Fynbos Subassociation (Coast Fynbos Alliance: Dune Mixed Fynbos Association), which occurs in the Cape of Good Hope Nature Reserve on "deep white or grey Fernwood sand" (Taylor, 1969)	An open upper stratum of *Thamnochortus erectus* to 1,3 m and a denser 0,4 m lower stratum of other graminoids, e.g. *Hypodiscus willdenowia* (physiognomically very prominent) and *Scirpus membranaceus*, and ericoid shrubs, e.g. *Phylica stipularis*; vegetation adjacent to that in which *S. cyanoides* grew was marked by the proteoids *Leucospermum conocarpodendron* (slopes of Table Mountain Sandstone shallowly overlain by sand) and *Leucadendron coniferum* (relict "perched" dune of transported, possibly neutral sand)	sandy slopes of Karbonkelberg
P. odorata	Scattered to densely grouped plants in ericoid-restioid Coastal Rhenosterbosveld (*sensu* Taylor, 1978) with 40–60 % projective foliage cover	(i) A main 0,6–0,7 m stratum dominated by the "heath-like" shrub *Elytropappus rhinocerotis*, a ground stratum of wiry restioids (e.g. *Leptocarpus rigoratus*), succulents (e.g. *Lampranthus aduncus*), low ericoids (e.g. *Diosma hirsuta, Macrostylis villosa*) and forbs, and a scattered emergent stratum (to 2,0 m) of the proteoid shrub *Leucadendron verticillatum*	clay slopes of Joostenberg Hill
		(ii) Similar to but lower and denser than the above; a main 0,4–0,5 m stratum was composed predominantly of tufted restioids (e.g. *Restio macer*), while *Leucadendron thymifolium* and *L. corymbosum* formed the emergent stratum	sand-clay flats near Kalabaskraal
P. mucronifolia	Scattered to densely grouped plants in ericoid-restioid Coastal Rhenosterbosveld, with 30–60 % projective foliage cover	(i) A main 0,4–0,5 m stratum of "heath-like" shrubs (e.g. *Relhania ericoides, Elytropappus rhinocerotis*) and wiry restioids (e.g. *Restio cuspidatus*) and a scattered emergent stratum of spindly proteoid shrubs of *Leucadendron corymbosum* to 2,0 m	clay flats near Barthlomews Klip
		(ii) Similar to but far denser than the above; a main 0,6–0,7 m stratum of low proteoid (e.g. *Leucadendron lanigerum, L. stellare*) and ericoid shrubs and tufted restioids (e.g. *Restio triflorus*)	clay flats near Voëlvlei; small proportion of sand in the clay

TABLE 2

Frequency of presence and absence of Restionaceous and Proteaceous associates, in populations of study species of *Serruria:* 1 = *S. trilopha*, 2 = *S. linearis*, 3 = *S. furcellata*, 4 = *S. cyanoides*. Numerator equals the number of populations in which the associate species was recorded within 0,5 m of plants of the study species; denominator equals total number of investigated populations per study species; "+" denotes associate species present in the same stand of vegetation as the study species but not within 0,5 m. See Table 3 for explanation of percentages in parentheses.

Associate species	Study species			
	1 (4 %)	2 (17 %)	3 (0 %)	4 (45 %)
Serruria decipiens R. Br.	1/2	+		
Leucadendron cinereum (Solander ex Ait.) R. Br.	1/2	+		
Protea pulchra Rycroft	1/2	+		
Leucadendron thymifolium (Salisb. ex Knight) Williams	+	+		
Leucadendron lanigerum Buek ex Meisn.	1/2	1/3		
Chondropetalum nudum (Nees) Rottb.	1/2	1/3		
Serruria burmannii R. Br.	1/2	2/3		
Restio monanthus Mast.	2/2	3/3		
Leucospermum parile (Salisb. ex Knight) Sweet		2/3		
Restio form of *sieberi* Kunth		2/3		
Restio filiformis Poir.		2/3		
Cannomois acuminata (Thunb.) Pillans		3/3		
Leucadendron corymbosum Berg.		+		
Restio bifurcus Nees ex Mast.		1/3	+	
Staberoha cernua (L.f.) Dur. & Schinz		+	+	
Chondropetalum acockii Pillans		+	+	
Hypodiscus aristatus (Thunb.) Nees			+	
Restio quinquefarius Nees			+	
Serruria ciliata R. Br.			+	
Restio paludosus Pillans			+	
Elegia juncea L.				1/1
Thamnochortus erectus (Thunb.) Mast.				1/1
Elegia vaginulata Mast.				1/1
Leucadendron coniferum (L.) Meisn.				1/1
Leucospermum conocarpodendron (L.) Buek ssp. *viridum* Rourke				1/1
Willdenowia teres Thunb.				+
Leptocarpus vimineus (Rottb.) Pillans	2/2	3/3	+	
Thamnochortus punctatus Pillans	2/2	3/3	1/1	
Staberoha distachya (Rottb.) Kunth	2/2	3/3	1/1	
Leptocarpus impolitus (Kunth) Pillans	2/2	2/3	+	
Thamnochortus obtusus Pillans	2/2	2/3	1/1	
Willdenowia arescens Kunth	2/2	3/3	1/1	
Restio sp. nov. aff. *R. tenuissimus* Kunth	2/2		+	
Chondropetalum tectorum (L.) Pillans	1/2		+	
Protea repens (L.) L.	1/2		+	
Willdenowia striata Thunb.	2/2	2/3	1/1	
Leucospermum hypophyllocarpodendron (L.) Druce spp. *canaliculatum* (Buek ex Meisn.) Rourke	2/2	2/3	1/1	
Diastella proteoides (L.) Druce	+		+	
Willdenowia sulcata Mast.	+	3/3	1/1	
Protea acaulos Thunb.	1/2	2/3	+	1/1
Leucadendron salignum Berg.	2/2	1/3	1/1	1/1
Protea scolymocephala Reich.	2/2	2/3	+	1/1
Restio cuspidatus Thunb.	1/2	2/3	+	1/1
Hypodiscus willdenowia (Nees) Mast.	2/2	2/3	1/1	1/1
Thamnochortus fruticosus Berg.	1/2	+		1/1

TABLE 3

Frequency of presence and absence of Restionaceous and Proteaceous associates in populations of study species of *Protea:* 1 = *P. odorata*, 2 = *P. mucronifolia*. Explanation of occurrence values as for Table 2. Percentages in parentheses at top of columns indicate proportion of associates unrecorded for the other study congener.

Associate species	Study species	
	1 (59 %)	2 (27 %)
Thamnochortus bachmannii Mast.	+	
Willdenowia striata Thunb.	+	
Serruria incrassata Buek ex Meisn.	+	
Staberoha cernua (L.f.) Dur & Schinz	+	
Willdenowia arescens Kunth	+	
Leptocarpus vimineus (Rottb.) Pillans	+	
Hypodiscus willdenowia (Nees) Mast.	+	
Elegia squamosa Mast.	2/2	
Thamnochortus fruticosus Berg.	1/2	
Thamnochortus punctatus Pillans	1/2	
Leucadendron thymifolium (Salisb. ex Knight) Williams	1/2	
Leucadendron verticillatum (Thunb.) Meisn.	1/2	
Elegia sp. nov. Esterhuysen 34411	1/2	
Restio sp. nov. Esterhuysen 30849	1/2	
Thamnochortus obtusus Pillans	1/2	
Serruria brownii Meisn.	1/2	
Elegia vaginulata Mast.	1/2	
Restio sp. nov. Esterhuysen 32525	1/2	
Leucadendron cinereum (Solander ex Ait.) R. Br.	1/2	
Protea scolymocephala Reich.	1/2	
Restio duthieae Pillans	2/2	+
Restio macer Kunth	1/2	+
Hypodiscus paludosus Pillans	2/2	1/2
Chondropetalum rectum (Mast.) Pillans	2/2	1/2
Leucadendron lanigerum Buek ex Meisn.	1/2	1/2
Leptocarpus rigoratus Mast.	2/2	2/2
Restio cuspidatus Thunb.	2/2	2/2
Elegia parviflora Kunth	2/2	2/2
Leucadendron corymbosum Berg.	1/2	2/2
Restio triflorus Rottb.	+	1/2
Restio sp. nov. Esterhuysen 30859		1/2
Leucadendron stellare (Sims) Sweet		2/2
Thamnochortus sporadicus Pillans	(+)	2/2
Serruria candicans R. Br.		+